Report of the

TWENTY-SECOND SOUTHERN PASTURE AND FORAGE CROP IMPROVEMENT CONFERENCE

Noel Hotel
Nashville, Tennessee

June 22, 1965

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
Crops Research Division

CR-63-65

Report of the

TWENTY-SECOND SOUTHERN PASTURE AND FORAGE CROP IMPROVEMENT CONFERENCE[1/]

Noel Hotel
Nashville, Tennessee

PROGRAM

Tuesday - June 22 - Morning

Tuesday - June 22 - Afternoon
Special Interest Groups

I. Forage Crop Breeding and Genetics Interest Group

W. C. Johnson, Presiding

1/ Reported by: R. C. Leffel, Permanent Secretary, USDA, Beltsville, Maryland.

Tuesday - June 22, 1965 - Morning

C. Y. Ward, Presiding

Opening Session

The twenty-second meeting of the Southern Pasture and Forage Crop Improvement Conference was opened by Conference Chairman, Dr. C. Y. Ward. Dr. Ward extended a welcome to all, thanked Local Arrangements Committee for their work, and introduced Dr. Henry A. Fribourg, Chairman, Local Arrangements Committee. Dr. Fribourg explained Registration procedures and announced tours for wives and children during the afternoon.

Chairman Ward introduced Past-Chairman O. C. Ruelke, Permanent Secretary D. E. McCloud, Chairman-Elect W. B. Anthony, Chairman-Elect-Elect H. A. Fribourg, S-46 Chairman E. F. McClain, S-47 Chairman W. W. Huffine, S-45 Chairman C. B. Browning, Forage Crop Breeding and Genetics Interest Group Chairman W. C. Johnson, and Forage Physiology and Ecology Interest Group Chairman R. H. Brown. Dr. McCloud's resignation as Permanent Secretary, due to assumption of duties as Agronomy Head, University of Florida, Summer 1965, was announced. The Nominations Committee Report, presented by E. C. Holt, nominated R. C. Leffel as Permanent Secretary. The motion "to close nominations and to instruct the Secretary to cast an unanimous ballot" was passed unanimously.

Members in attendance were introduced by States and by National Organizations. Dr. Fribourg chaired the following morning's program:

Welcome to Tennessee - Webster Pendergrass, Dean, College of Agriculture, University of Tennessee.

Dr. Pendergrass welcomed the Southern Pasture and Forage Crop Improvement Conference to Tennessee and complimented the organization on its accomplishments during past years. The Second National Grasslands Field Day was cited as creating much interest in Tennessee in forage production and utilization. The institutions of higher learning, geography, agricultural enterprises, and Experiment Station organization of Tennessee were reviewed.

The Application of Agricultural Research to Actual Farm Conditions: The Ames Plantation Program - T. J. Whatley, Head, Department of Agricultural Economics, University of Tennessee.

In 1950 the University of Tennessee, College of Agriculture, received the use of the 18,400 acre Ames Plantation in West Tennessee for research and educational purposes under the Will of the late Mrs. Julia C. Ames. Since that time research programs have been developed on the Plantation in forestry, livestock breeding and management, and farm management.

There were 56 tenants on the Plantation in 1956 and they were leasing on a standing rent basis. The typical tenant had a "2-horse crop" and was paying 2 bales of cotton for rent of land and buildings. His cropping system consisted of approximately 10 acres of cotton, 10 acres of corn, and 25 to 30 acres of pasture. His gross income ranged from $1,500 to $2,[illegible] annually.

In 1957 an intensive farm management program was started on five tenant farms. The objectives were: 1) to increase total income on tenant farms, 2) to provide ways for both the tenant and the Plantation (as landlord) to share in this increased income, and 3) to work out methods for financing these operations.

Emphasis was placed on producing high valued enterprises, such as cotton, corn, soybeans, hogs, Grade A dairy, and sheep. In general, the tenant paid 2/3 of the operating expenses and received 2/3 of the gross income from these enterprises, while the Plantation shared the balance. The tenant provided the labor and the Plantation furnished the land and capital improvements.

The average income and expenses on the five farms by years are indicated below. The average cash expenses on a farm on the intensive program in 1957 was approximately 6 times higher than expenses under the old farming system in 1956.

Year	Cash Income	Cash Expenses	Net Cash Income
1956	$ 1,624	$ 512	$ 1,112
1957	5,576	2,984	2,592
1958	[illegible]	4,652	5,366
1959	8,772	4,542	4,230
1960	[illegible]	4,757	5,046
1961	10,327	[illegible]	4,525
1962	17,124	9,243	7,881
1963	19,629	9,884	9,745
1964	21,197	11,253	9,944

In 1962 the average size of farm was increased from 100 to 150 acres of open land, and the 2-row equipment was exchanged for 4-row equipment.

During 1964 the tenants' share of net cash income ranged from $4,300 to $7,655 per farm, while the Plantation's share ranged from $2,538 to $6,988 per farm. The Plantation invested an average of $15,000 per farm between 1956 and 1964. The tenants' average investment per farm was about $6,000 in livestock and equipment.

Since the beginning of this project, the actual net cash income per farm has exceeded the estimated net cash income by approximately 5 percent.

<u>The Last 25 and the Next 25 Years of Forage Crop Production in the South</u> - O. S. Aamodt, (USDA, retired), Hyattsville, Maryland.

<u>The Last 25 Years</u>

My first contact with agronomists and specialists in related fields of research in the South was at the annual meeting of the American Society of Agronomy in New Orleans, December 1939. It was very evident at this meeting that the primary interest of the leaders in the southern agricultural institutions was in cotton, tobacco, sugarcane, and other crops important to the agricultural economy of the region. Considerable progress had been made over a long period of time in developing improved experimental procedures with well defined research objectives in these leading crops.

In forage and pasture crop research an entirely different situation prevailed. In fact, pastures were not even considered to be an important crop in the agricultural economy of the region. The South was not alone in this attitude. The so-called "cash crops" were receiving the attention of specialists in conference and council groups, with the object of coordinating their separate endeavors and exchanging viewpoints on problems and objectives. The exchange of ideas and materials brought about cooperation that advanced accomplishments far beyond the efforts of individuals with limited support and facilities. A prize example of coordination of research is the production and use of hybrid corn.

Conference groups of research specialists can contribute to the advancement of their mutual problems and interests when they are able to confer with each other and exchange viewpoints in the early planning of their experimental projects. Pasture conferences and research were receiving special attention in Europe. A well known organizer and promoter of forage and pasture improvement was Director Stapleton in Wales. I had the good fortune to spend part of the summer of 1928 with him and his staff at Aberystwyth. After this early experience I developed an understanding of range problems and needs in Alberta, Canada, and of the problems concerned with intensive dairy production in Wisconsin. In the meantime, soil improvement and conservation, after years of neglect, were receiving the attention of American farmers and institutional workers. It was obvious that in addition to improved cultural practices, erosion resisting crops would be essential. Their development and use as an integral part of our cropping system and land use brought about the dawn of a new day in grassland research. We were on the threshold of a new field of investigation.

During the past 25 years there has been an increase of well over 100 percent in industrial development in the Southern States. The increased purchasing power of industrial workers created an unprecedented demand for quality livestock products. There was an increase of beef cattle numbers of over 300 percent during this same period in the South. Producers of both livestock and cash crops realized the need for greater efficiency in production of feed to meet rising costs. Unimproved grassland acres were estimated at approximately 70 million acres. There was a dearth of information on methods for the efficient production of palatable and nutritious forage and pasture crops. There was also a prevailing belief that livestock feed requirements could be balanced with "concentrates" to supplement whatever "roughage" that might be available as refuse from other crops, or volunteer growth of weeds and native herbs after harvest of the money crops. Livestock specialists are now agreed that the key to profits in livestock production is good forage, not "roughage" to be supplemented with expensive "concentrates." It is now generally agreed that inferior bulk feeds, such as corn stalks and oat straw have little in common with good forage. Cooperative feeding trials conducted by the agronomists and livestock nutritionists have demonstrated that hay and silage made from superior forage crops, processed and stored by methods that preserve their superior nutritional qualities, has resulted in larger gains at lower cost than the so-called "roughage." This type of cooperative research between the agronomists and livestock specialists, I believe to be the primary development in the past 25 years; it laid the groundwork for present programs. This arrangement was not accidental as can be noted in the initial organization of the Southern Pasture and Forage Crop Improvement Conference, when early conference leaders requested the American Dairy Science Association and the American Society of Animal Science to appoint official representatives to the Southern Pasture and Forage Crop Improvement Conference from their respective Societies. Livestock specialists were asked to attend and participate in all activities of the Southern Pasture and Forage Crop Improvement Conference. Evidently this high standard of cooperation has not yet penetrated all areas of the United States. An Assistant Director of one of our northern State Experiment Stations, in the February 1965 issue of "Crops and Soils," states that the agronomist often develops management practices assigned to forage crops, "without regard or concern of the animal nutritionist, economist, farmer, or forage consuming animals." He must have been referring to a local situation!

In a number of the underdeveloped countries in which I have had the privilege of working, the veterinarians are in control of livestock production and the forage and pasture programs. The veterinarians, with little or no training in crops and soils in most of these countries, have made little progress in efficient livestock production. In many areas the livestock are mere scavengers for food, sometimes supplemented with by-products of food processed for consumption by

humans, many of whom likewise have insufficient food for normal growth and energy to do hard work. Some progress is being made, however, in the underdeveloped areas in improving the food requirements of livestock. Education of the people for more adequate human diets, and the shift of agricultural workers into industrial developments, will modify greatly, their own need to produce livestock products. It will also increase their needs and consumption of imported supplies of food produced on our pastures and forage fields. A few of the problems and the progress being made in some of these foreign areas will be illustrated with Kodachrome slides at the end of this talk.

The Southern Pasture and Forage Crop Improvement Conference recognized the need to take the "public" into consideration on these objectives. The Pasture Improvement Committee considered the desirability of the group sponsoring, or assisting, regional groups with general meetings to which the public would be invited, these general meetings to be held for one or two days immediately following the technical conferences.

The first regional Grassland Conference in the country was held at the Georgia Coastal Plain Experiment Station, Tifton, Georgia, July 25-26, 1940. The Conference was sponsored jointly by the Association of Southern Agricultural Workers and Pasture Committee of the American Society of Agronomy. The meeting had an enthusiastic attendance of about 500 people.

While the primary aim of the southern regional grassland conference is to bring together the technical workers such as agronomists, soil, range, dairy, livestock, nutrition, farm management, and economic specialists, leaders of farm organizations, extension workers, county agents, specialists in agricultural departments of industries, and railroads and financial institutions, there is still the need to bring the grassland problems and methods for improvement to the attention of the farm and ranch operators.

The pattern for regional grassland conferences developed in the South set a precedent for other regions to follow. Several of the State institutions proceeded to make arrangements for State grassland conferences. Field Days became "Grassland Days, Pasture Days, etc." Industrial organizations concerned with forage seeds, fertilizers and new machinery held meetings and arranged for field demonstrations of their new materials and equipment. This latter group has developed a permanent grassland organization known as the American Grassland Council. It sponsors national conferences in cooperation with State grassland councils. One of their national meetings arranged jointly with the University of Tennessee follows this conference at Columbia.

Another group of grass specialists working the more arid regions of the Western States had similar needs to those of the southern conference for an organization to advance their mutual interests in range research and improvement. They organized in 1947 as The American Society of Range Management, and now are making great contributions to range management and improvement.

Mr. Gove Hambidge, editor of the U. S. Department of Agriculture Yearbook, noted the interest and enthusiasm for grassland improvement over the entire country and proposed consideration of a "Grassland Yearbook." A "Grass" Yearbook was developed with close cooperation between Federal and State specialists in this field and published in 1948. It was interesting to note that in the few years following the distribution of the "Grass" Yearbook in 1948, six new textbooks on forages and pastures appeared on the market. The teaching and educational specialists immediately saw the need for incorporating the new developments on forages and pastures into their secondary schools and college curricula.

In the meantime, interest among American pasture and livestock specialists in the European grassland congress was growing. That organization arranged to expand its area of activity at the 1949 meetings in Holland to an International Grassland Congress. They then held their fifth congress in the United States in 1953 at State College, Pennsylvania. Since this southern conference group was a vital ferment in the early recognition of the need for research in the improvement, production, and use of forage and pasture crops in the United States, it seemed proper to make this brief review on the twenty-fifth anniversary conference. You are to be highly congratulated not only for your own technical contributions, but also for the stimulus and support you gave over the past quarter century to State, National, and International developments in forage and pasture production and research.

At the first conference in Tifton, Georgia, in 1940, the people present were asked to suggest specific topics for consideration at future meetings. Eighteen topics were suggested and reported as part of the minutes of that meeting. The list of suggestions covers almost every topic of research that has been investigated since that time.

All of the problems proposed are still with us even though a great deal of progress has been made in almost every one of the original suggestions. A review of all of the reports of the Southern Pasture and Forage Crop Improvement Conferences since that time demonstrated a marked trend toward greater emphasis on basic research in related biological sciences concerned with the soils, plants, and animals. I shall continue with the same theme and attempt to equate developments of the past quarter century with lights and shadows now on the horizon and their possible significance in the next quarter century.

When I mentioned the title of this talk to one of the leading scientists in Washington, he promptly suggested using a "crystal ball" as a source of ideas and opinions on what will be of consequence in the "next 25 years!"

The Next 25 Years

An obvious trend that has developed during the past quarter century is the shift in emphasis from applied to basic research. Basic research is often defined as research primarily to advance human knowledge, while applied research is research primarily to improve technology and development. Basic research often produces results that are of immediate application to the solution of practical problems. Likewise applied research often points out the need for a better understanding of fundamental principles and basic research. There is an interdependence of basic and applied research that nullifies a clear and final classification or definition of these terms. The present clamor for basic research seems to be largely a desire for a greater improvement in applied research and technological skills, also a demand for improved facilities and financial support. Whether any particular research project is basic or applied, depends to a large extent upon the motivation of an idea or ideas in the mind of the scientist. The administrative organization should provide a sympathetic but critical atmosphere, but should as far as possible, avoid inhibition of freedom of thought and grant fluidity of plans and goals.

The biologists, which includes the plant and animal scientists, have recently expressed concern over their status in the competitive atmosphere that envelops them with nuclear scientists. An editorial in the AIBS Bulletin for June 1962, reads in part as follows: "Too often we accept the achievements in the biological sciences as a matter of course. Most of us are no longer aware to what extent biological concepts such as growth, differentiation, evolution, nutrition, parasitism, and heredity are fundamental to our thinking in all disciplines-economics, sociology and the humanities, and above all, medicine. Physicists and chemists have achieved recognition through fantastic advances in technology based on basic research. Biologists have not received similar recognition."

Charles Percy, president of Bell and Howell, Inc., optical and electronics firm, recently expressed a widespread feeling that defense needs dangerously reduce the men and facilities available for research in consumer goods. "I am concerned," he said, "that so many good men are engaged in space activity that is not truly wealth producing. We simply must find better ways to make use of the talents we have."

But let us come back to the more critical needs of pasture and forage research. Agricultural production and development need the support of basic research, not only to maintain its position in the

expanding economy, but also to service a changing and increasingly competitive complex program of production, processing, service and distribution. Since products of agricultural research become an endowment of benefit to most countries of the world, it is only natural for research institutions to cooperate in advancing the knowledge on improved production through cooperation and coordination of their programs and activities.

Have our agricultural educational institutions failed to maintain their responsibilities in producing qualified specialists for the rapidly changing total agricultural industry? In their attempts to keep pace with the rapidly expanding nonproduction aspects of agricultural industry will the applied research, so fundamental to efficient and economical production, be neglected? Present trends in university and college curricula are moving in that direction.

In the first half of the present century, agriculture was concerned chiefly with research applied to production. Many of the processing, servicing and distribution phases seem to have left the agricultural fold and become activities of independent groups. In the United States we now boast about the efficiency of our agriculture with statements to the effect that it now takes only seven million farmers to feed 180 million people of our country, and in addition have a surplus to feed more millions of people abroad. Dean O. J. Burger of West Virginia has provided an interesting analysis of this situation. He says, "Believe it or not, there is a marked shortage of qualified agricultural graduates in America today. The shortage abroad is much greater. But why does this exist? Why don't more high school students prepare themselves for challenging careers in the field of agriculture?"

Perhaps the primary reason for this dilemma is the public image of American agriculture. Regrettably, the public erroneously equates agriculture with the farming phase only. Agricultural servicing industries are now moving rapidly into applied research and some into basic research.

Agriculture actually consists of three separate segments, production, processing, and services. About seven million farmers in the United States are directly engaged in production of crops and livestock. At least eleven million people process, store, handle, and merchandise our farm abundance. Another six million people supply and service the farmer. The total is still approximately one-third of the U. S. labor force.

The administrators and faculty members of many of our colleges and universities are under pressure, or have a strong desire, to adjust their scientific research for the financial support of the so-called basic sciences and the specialized science students. Some universities are considering moving the present limited basic science training out of the agricultural faculties, or colleges, to pure science faculties

within the institution. This may be the answer to the problem provided there is coordination of objectives and purposes that will provide the future scientists with the training and skills they need to maintain and expand agriculture as an industry. Many countries have failed to develop or make available technical services to agriculture. Others have lost their service institutions and research organizations in their struggle for freedom. Still others who had their freedom, lost it, and the technical services, and the means to carry on a productive agriculture. In many areas the greatest need at present is vocational training, based on research findings. Keeping up with the farmers is not enough. The scientist needs a reservoir of factual information to keep up with the rapidly changing technology, especially the advances made by the servicing industries. What is basic today becomes applied tomorrow.

A complete listing of pasture and forage research projects has been compiled by the U. S. Department of Agriculture, Division of Federal-State Relations. Copies of these lists are on file with each cooperating State experiment station. It is beyond the purview of this talk to attempt to detail or even summarize that compendium of information. A perusal of the statements describing each project is informative and thought provoking.

The responsibility for the training of agricultural producers and the promotion and adaptation of new developments is likewise receiving the close attention of institutional administrations, government planners, and politicians. Should the agricultural producers who now consist of only 7 percent of our labor force continue to receive the same support as they have in the past? The idea now prevails that all segments of our population should receive similar support and services from the government to promote efficiency in their occupations and a standard of living commensurate with our national economy. If industry takes the lead in applied agricultural research, will they likewise take over the responsibility for promotion and extension? If the colleges and experiment stations program are limited to basic research, and training of graduate students for advanced degrees, will the agricultural producers and other segments of agribusiness continue to back our present teaching and research institutions?

At the present time approximately one-half of the beginning college students are going to Junior and Community colleges. Some of the universities have, or are in the process of transferring, teaching research and extension to their departments of biology, chemistry, mathematics, engineering, etc. In the meantime some of the Junior colleges are expanding their curricula to four year courses with Bachelor of Science or Arts degrees upon

graduation. If this trend continues they may soon be in a position to enter the field of research and grant Master of Science and Ph.D. degrees!

A major part of our foreign aid to the less developed countries around the world is concerned with education and research. Overpopulation, underdeveloped national resources and the lack of technical knowledge result in economies that fail to provide even a minimum standard of living. The number one problem in these situations is the lack of food that will provide health and energy for the people for the development and production of essential agricultural and industrial facilities. The major need is food that will result in sustained energy for labor. In most countries the greatest shortage in food for normal growth and development of the people is animal proteins, usually supplied from diets containing meat and dairy products.

There are approximately 70,000 foreign students studying and being trained in the United States at the present time. Many of these students are studying in the biological, agricultural, and food sciences. They are being sponsored by Federal, State, and charity institutions, individual and private organizations. Your participation as teachers and leaders in research in these important international developments will be an important consideration in your teaching, research and extension in the next 25 years.

<u>Business Meeting</u> - Chairman Ward, Presiding.

The annual business meeting of the Southern Pasture and Forage Crop Improvement Conference was called to order by Chairman Coleman Ward. Chairman Ward announced a Resolutions Committee of W. E. Knight, Chairman; T. H. Taylor, and E. R. Beaty.

The Report of the Nominating Committee (E. C. Holt, Chairman; W. B. Anthony, and O. C. Ruelke) by E. C. Holt, nominated L. H. Taylor as new Executive Committee member. It was moved and seconded that the nominations be closed and that the secretary be instructed to cast an unanimous ballot for L. H. Taylor; motion passed unanimously.

A motion - "that the Southern Pasture and Forage Crop Improvement Conference recommends that the Chairman of each of the three interest groups or his representative be members of the SPFCIC Executive Committee" - carried.

Chairman Ward and Local Arrangements Chairman Henry Fribourg expressed thanks to program participants and planners. The meeting was adjourned at 12:45 p.m.

Tuesday - June 22 - Afternoon

SPECIAL INTEREST GROUPS

I. Forage Crop Breeding and Genetics Interest Group

W. C. Johnson, Presiding

Crown Vetch, Coronilla varia, for Forage in the South - Will A. Cope

Crownvetch, Coronilla varia L., is a new forage crop that appears to have the potential for producing competitive quantities of nutritious forage. The genus includes 20-30 species of annuals and herbaceous and shrubby perennials centered around the Mediterranean and central Europe. Various species have served as forage plants in the native habitat; crownvetch has been used as an ornamental in North America and only in the last two decades has attention been focused to create interest in it as a forage crop.

Crownvetch is a hardy, herbaceous, long-lived perennial with a growing season similar to that of alfalfa. Stems are hollow, weak, with a tendency toward a trailing habit; leaves are pinnate, usually with 6-13 pairs of leaflets. Flowers are in rather dense umbels; flowering begins in late spring and, the plant being indeterminate, continues during much of the summer. Pods have up to 15 ovules, mature pods being cylindrical, segmented, and non-dehiscent.

The characteristic of primary importance in considering crownvetch for forage is its exceptionally effective creeping-rooted habit. Stems arise from roots growing laterally, often up to 3-4 feet distant from the crown in case of cultivated plants. When plants are spaced 3.5' x 3.5' and cultivated the first year, new crowns are numerous in the fall and a full cover established the next spring. In addition, no serious disease nor insect problem is known at present. Bloating is not a problem.

There are certain limitations to the use of crownvetch at present. Seed are expensive, reflecting both production and processing problems. Germination and growth of seedlings are slow; best methods for establishment have not been worked out. Little is known about soil fertility and crop management. Crownvetch does not appear to be adapted to areas South of Piedmont. There are still some unsettled questions concerning palatability and possible toxicity.

Most of the studies on establishment and production of crownvetch are from the SCS. On Georgia roadbanks, crownvetch was successfully established by Mr. E. C. Richardson both in spring and fall. A mulch or nurse crop was necessary, and cool season grasses in association were excessively competitive with the

crownvetch. A study by Mr. V. B. Hawks of a number of plantings in Iowa resulted in conclusions that factors limiting growth of crownvetch were: soil wetness, low available potassium, soil acidity, and low available phosphorus, in that order.

Seeding rates used have often been 15-20#/A. Thin stands in case of partial failure or with light seedings sometimes require 2-4 years to attain full cover. In all cases one full growing season is necessary. Inoculation with the proper strain of Rhizobium is necessary. Weed control by use of Eptam, EPTC, or TCA and dalapon has been reasonably successful.

Preliminary data on hay yield from Iowa and Pennsylvania indicate crownvetch has a production potential similar to that of other common forages. The first cut may be exceptionally heavy, regrowth is slow, and, consequently, the number of cuts may be less than in case of alfalfa. Dr. Darell McCloud has reported a study indicating that heavy grazing followed by a long recovery period gives higher dry matter yield than other combinations of grazing and recovery periods.

There is little experimental evidence, but private reports indicate satisfactory performance of both beef and dairy animals on crownvetch. Chemical analyses and digestibility estimates from Pennsylvania support the contention that crownvetch forage is equal to other common forages in nutritive value. Dr. P. J. Reynolds in studies with sheep found no palatability problem and no evidence of toxicity. He concluded that energy digestibility and voluntary consumption of crownvetch forage was of a similar order of magnitude to that of other common forage legumes.

Three varieties of crownvetch have been released, Penngift in Pennsylvania, Chemung in New York, and Emerald in Iowa. Many other local strains have been collected for observation. As the name _varia_ implies, crownvetch is quite variable in morphology, color, maturity, spring growth, creeping-rooted habit, and chemical characters, such as, tannin and protein. Botanically, it is a self-sterile plant of tetraploid origin, 2n = 24. Bees effect cross-pollination. Plants are readily cloned, and, therefore, subject to various systems of combining plants from the single cross to the synthetic.

In North Carolina we expect to make signif[illegible]t [illegible] in present varieties which are largely the result of natural selection in climate different from ours. In a short range program, polycross progenies of the most successful plants developing under conditions of fairly severe weed competition for three years will be tested for improvement over parental varieties Penngift, Emerald, and Chemung. Successful competitors include a wide range in morphological type and maturity. In a more basic study aimed at long range improvement, approximately

20 plants representing the range in type, vigor, and maturity have been intercrossed in various combinations to obtain sufficient seed for space-planted plots which should attain full cover for hay yield. The study should indicate the type most suitable for North Carolina conditions, combining ability, and relationships among combining ability and other characters.

It has been determined that crownvetch is resistant to common forms of root-knot nematode which is a highly desirable characteristic for a forage legume in the South.

References

Henson, Paul R. Crownvetch, a soil conserving and a potential pasture and hay plant. ARS 34-53, 9 p. April 1963.

Proceedings of the Crownvetch Symposium, the Pennsylvania State University, 82 p. July 1964.

Richardson, E. C., E. G. Diseker, and B. H. Hendrickson. Crown-vetch for highway bank stabilization in the Piedmont Uplands of Georgia. Agronomy Journal 55:213-215. 1963.

Progress in Breeding of Creeping Alfalfa - N. L. Taylor

This program, initiated in 1955, has as its objective the breeding of a creeping-type alfalfa adapted to grazing conditions. The requirements of this type of alfalfa are: a high percentage of creeping plants, medium high vigor or yield, persistence under grazing, and at least adequate performance in other characteristics.

Crosses were made between clones selected from material related to Rambler and clones from 4 varieties reasonably well adapted in Kentucky; Narragansett, Atlantic, Vernal, and Rhizoma. 19.8 percent of the F_1 plants were creeping in bluegrass sod 2 years after transplanting.

Approximately 110 of the most strongly creeping plants were vegetatively increased and established in a polycross nursery. Polycross seed was harvested and three types of progeny tests were established in various locations throughout the state.

The percentage of creeping of progenies spaced-planted in bluegrass sod was increased from 19.8 to 32.5 by one cycle of selection. The range in families was 14.3 to 61.7 percent. The variety Rambler, used as a check, possessed approximately 1.8 percent creeping plants in both cycles of selection. Few or no differences among varieties used in the original crosses were found.

None of the families or check varieties when sown in rows, overseeded with bluegrass, and exposed to differential clipping managements which simulated various grazing pressures were particularly tolerant of frequent defoliation. However, creeping

was observed under the 7-harvests-per-year as well as the 4-harvests-per-year-management systems. Height of clipping (1 inch vs. 3 inch) favored the 1 inch height but was less important than frequency of harvesting.

Forage and seed fields of polycross progenies in broadcast plots were on the average less than of the variety Narragansett but some progenies were equal to Narragansett in both characters. All progenies recovered more slowly after harvests than did Narragansett.

It may be concluded that although the percentage of creeping plants in the breeding population was low, significant progress was made in 1 cycle of selection. Inasmuch as creeping was not found to be associated with tolerance of frequent clipping, all further selections will be made from among plants established in rows exposed to this management. Vigor of growth and recovery, although not equal to standard hay-type varieties was probably adequate for a variety of the grazing type. The breeding materials will be subjected to livestock grazing at an early date to insure that the proper type of selection is being practiced.

nematode

An Improved Method of Screening Plants for Root-Knot Resistance - R. L. Shepherd, N. A. Minton, and E. D. Donnelly

The most common method of screening plants for root-knot resistance in the greenhouse consists of exposing plants to inoculum composed of finely chopped root-knot infected roots and/or soil in which infected plants have been grown (1).

This report is concerned with an improved method of screening for resistance. The method was developed using individual vetch and sericea lespedeza plants inoculated with known numbers of surface disinfected root-knot larvae.

Larvae were collected from galled tomato roots incubated in a modified mist chamber described by Seinhorst (3). The nematodes were concentrated in a small volume of water by collecting them on a 325-mesh screen. Debris was separated by washing the nematodes from the screen onto a double thickness of facial tissue. The tissue was supported in a Petri dish on a flat bottom wire basket (4). Sufficient water to contact the bottom of the tissue was placed in the Petri dish allowing the larvae to migrate through the tissue into the water below.

Larvae collected during a 3-day period were surface sterilized by placing them in 0.001% 8-hydroxyquinolin sulfate for 30 minutes, after which they were returned to tap water (2).

Tests were conducted in greenhouse benches 15 cm deep, 100 cm wide, and 240 cm long. Fertility and pH of the soil were adjusted as needed for each crop. Soil temperature was maintained between 20° and 27° C. Seeds were planted in holes spaced 2.5 cm in rows 5 cm apart.

Uniform holes were made with a special punch constructed of a 2.5 X 9.5 X 100 cm piece of plywood and round hardwood dowel stock measuring about 1 X 7 cm. Forty pieces of dowel stock were inserted into evenly spaced holes drilled along the center of the plywood strip. The pieces of dowel stock were driven into the holes until they extended uniformly the desired distance from the plywood surface. Forty uniform holes in a row were made at one time with this tool.

Ten scarified seeds per entry were planted in each of 4 replications. After the seeds were dropped into the holes (one seed per hole), a 1-ml aliquot of a nematode larval suspension was injected into each hole with an automatic pipette. The seeds and nematodes were then covered with soil.

Pathogenicity tests with _Meloidogyne_ _incognita_ (Kofoid and White, 1919) Chitwood, 1949; _M_. _incognita_ _acrita_, Chitwood, 1949; _M_. _javanica_ (French, 1885) Chitwood, 1949; _M_. _arenaria_ (Neal, 1889) Chitwood, 1949; and _M_. _hapla_, Chitwood, 1949; were made on five _Vicia_ species and 36 F_5 lines of an interspecific cross, _V_. _sativa_ L. X _V_. _angustifolia_ L. In a second test, two commercial varieties of sericea lespedeza (_Lespedeza_ _cuneata_ /Dumont/ G. Don.) and 41 breeding lines were used. Tomato (_Lycopersicon_ _esculentum_ Merr. 'Rutgers') was included in each test as a check on nematode infectivity. The plants were dug and rated for root-knot galls after the tomato and susceptible test plants were heavily galled. The plants were rated from 1 to 5. Plants having no galls or very light galling received a rating of 1 and those heavily galled received a rating of 5. The vetch plants were harvested 3-5 weeks after planting and the sericea plants 5-8 weeks.

Results and Discussion

Uniform results were obtained (Tables 1 and 2). Resistant, susceptible, and intermediate entries were clearly differentiated. Also, entries segregating for resistance were identified. Differences in the reaction of certain entries to the different nematode species were easily detected.

Results of the sericea experiment indicated the importance of a refined screening technique. All except one entry tested were field selected during a period of years on a soil known to be infested with _M_. _incognita_ _acrita_. Nevertheless, a large percentage of the entries tested against this species was found to be highly susceptible.

The advantages of inoculating with larvae rather than galled roots were: (1) number of larvae applied per plant was controlled; (2) same number of larvae were present to attack all plants at the same time; (3) placement of larvae relative to the root system was the same for all plants; (4) only viable larvae of nearly the same physiological age were used; (5) contamination with other disease organisms was reduced by surface sterilizing the nematodes and planting in sterilized soil, and (6) unfavorable growing conditions caused by decomposing galled roots were avoided.

Literature Cited

1. Barrons, K. C. 1938. A method of determining root-knot resistance in beans and cowpeas in the seedling stage. Jour. Agr. Res. 57:363-370.
2. Ducharme, E. P. 1959. Morphogenesis and histopathology of lesions induced on citrus roots by *Radopholus similis*. Phytopathology 49:388-385.
3. Seinhorst, J. W. 1950. De betekenis van de toestand van de grond voor het optreden van aantasting door het stengelaaltje (*Ditylenchus dipsaci* (Kuhn) Filipjev.). Tijdschr. Pl. Ziekten. 56:289-348.
4. ______________. 1956. The quantitative extraction of nematodes from soil. Nematologica 1:249-267.

Table 1. Reaction of two varieties and several breeding lines of sericea lespedeza to five *Meloidogyne* spp.

Root knot species	No. of lespedeza entries	Root-knot indices a/	Resistance rating b/
M. incognita	4	1.0-1.5 a c/	HR
	7	1.6-2.5 ab	R
	1	2.7 b	I
	16	2.9-3.9 bc	S
	15	4.9-4.7 c	HS
M. incognita acrita	2	1.3-1.5 a	HR
	3	1.8-2.6 ab	I
	7	2.7-3.6 b	I
	1	3.7-4.0 bc	S
	30	4.2-5.0 c	HS
M. hapla	12	1.0-1.8 a	HR
	6	2.0-2.7 ab	R
	4	2.8-3.0 b	I
	17	3.1-4.0 bc	S
	4	4.1-4.4 c	HS
M. arenaria	8	2.3-2.8 a	I
	27	2.9-3.9 ab	S
	8	4.0-4.6 b	HS
M. javanica	4	1.9-2.3 a	R
	19	3.0-3.4 ab	S
	20	3.5-4.5 b	HS

a/ Root-knot index based on 1 = no galls; 2 = very light galling; 3 = light galling; 4 = moderate galling; 5 = heavy galling.

b/ Ratings: HR = highly resistant; R = resistant; I = intermediate; S = susceptible; HS = highly susceptible.

c/ Indices with a letter in common within a root-knot species do not differ at P = .01, according to Duncan's Multiple Range Test.

Table 2. Reaction of *Vicia* species and breeding lines to five *Meloidogyne* spp.

Root-knot species	No. of vetch entries	Root-knot indices a/	Resistance rating b/
M. incognita	30	1.0-1.2 a c/	HR
	7	2.7-3.5 b	I
	1	3.6 bc	S
	5	4.7-4.9 c	HS
M. incognita acrita	30	1.0-1.9 a	HR
	2	4.1 b	S
	6	4.3-4.8 bc	HS
	5	4.9-5.0 c	HS
M. hapla	5	2.8-3.2 a	I
	34	3.3-4.3 ab	S
	4	4.5-4.7 b	HS
M. arenaria	3	3.1-3.3 a	I
	11	3.9-4.3 ab	S
	29	4.4-5.0 b	HS
M. javanica	30	1.0-1.2 a	HR
	2	3.4-3.5 b	I
	5	4.0-4.2 bc	S
	6	4.4-4.8 c	HS

a/ Root-knot index based on 1 = no galls; 2 = very light galling; 3 = light galling; 4 = moderate galling; 5 = heavy galling.

b/ Ratings: HR = highly resistant; R = resistant; I = intermediate; S = susceptible; HS = highly susceptible.

c/ Indices with a letter in common within a root-knot species do not differ at P = .01, according to Duncan's Multiple Range Test.

Chromosome Number Variations in *Cynodon* - J. B. Powell and G. W. Burton

The reported chromosome numbers for the various species of *Cynodon* have been in some disagreement. This disagreement has arisen mostly because (1) the studied material was not clearly identified, (2) the making of good cytological preparations of some material was technically difficult, and (3) the inherent variation of the material examined, particularly as regards reports of fragment chromosomes, made exact counts difficult.

The availability of over 300 Cynodon plant introductions provided the material to survey the clones for chromosome number. Of 43 different Cynodon dactylon clones examined, 23 were found with 36 chromosomes, 5 with 36 chromosomes plus fragment or accessory chromosomes, 9 with 27 chromosomes, 5 with 18 chromosomes, and 1 with 18 chromosomes plus a large accessory chromosome in some cells. Cynodon barberi was found to have 18, 27 and 36 chromosome types. Although the taxonomic identification of C. coursii and C. polevansii was subject to some doubt, the clones examined of these species had 36 chromosomes. Accessory or B-chromosomes are unmistakably present in Cynodon, being observed in tetraploid and triploid forms. They probably occur also in the diploid forms.

"Heterosis" - A Panel Discussion

Utilization of Heterosis in Forage Crops - J. P. Craigmiles

The utilization of heterosis manifested in F_1 hybrids is generally the ultimate aim in forage breeding since the greatest increase in yield can be realized through the use of F_1 hybrids. Apomixis, aneuploidy, cytoplasmic sterility, incompatability, gametocydes, phytocides are merely tools enabling the breeder to utilize hybrid vigor. Heterosis or hybrid vigor is generally defined as the increased vigor of the F_1 hybrid over the mean of the better parent or both parents. Although variously explained, it obviously results from the combined action and interaction of allelic and non-allelic factors. It is closely associated with heterozygosity and increases or decreases in direct proportion.

Heterosis from F_1 hybrids has been reported in many forage plants. Some of these species are alfalfa, brome-grass, orchard grass, Bahia grass, Napier grass, buffel grass, pearl millet, Bermuda grass, sericea lespedeza, Sudan grass, fescue, white clover, oats, wheat, and barley. Much of the work on heterosis has been done in the southern states, a considerable amount having been conducted by members of this panel.

Forage crop species include such a wide range of reproductive and propagative diversity that each species needs to be treated individually. Forage species include annuals, perennials, and biennials which reproduce vegetatively by cross-pollination and self-pollination or by a combination of methods. Examples of self incompatability, cytoplasmic sterility, and apomixis can all be found in forage plants.

Discussing the various techniques of utilizing heterosis, our panel consists of Dr. E. C. Bashaw who will report on apomixis in Dallisgrass; Dr. E. D. Donnelly will report on heterosis in Sericea lespedeza; and Dr. R. C. Buckner will discuss fescue hybrids.

Although some forage plants are difficult to develop F_1 hybrids due to the system of reproduction and minuteness of the flower, most forage species have definite characteristics that can be exploited. Probably the most difficult species to obtain sterility is in the self-pollinated annual that does not behave as a perennial under greenhouse conditions. Even when sterile plants are found, they cannot be maintained.

<u>Heterosis in Sericea Lespedeza and How It Can Be Utilized</u> - E. D. Donnelly

Sericea produces cleistogamous flowers that are self-pollinated and chasmogamous flowers that can be self- or cross-pollinated. The proportion of these can be changed by certain environmental factors. Cutting or grazing, for example, generally reduces the percentage of chasmogamous flowers and seed. These are important to the interpretation of results presented here.

Based on data from an experiment conducted in Alabama during 1951-1954, it was reported that heterosis occurred in outcrossed progeny of some sericea plants (1). This was manifest in increased forage and seed yields.

Since that time chasmogamous and cleistogamous progeny of a number of inbred lines have been compared. In a few lines the two types of progeny yielded the same amounts of forage. This was true for relatively low-yielding lines and also for a few high-yielding lines. However, chasmogamous progeny of one low-yielding line produced considerably more forage (44%) than cleistogamous progeny. Even so, the total of the two types was only 6 tons of green forage per acre.

Conversely, chasmogamous progeny of another line produced more forage (12%) than cleistogamous progeny and produced 13.5 tons of green forage per acre. In this study the chasmogamous progeny of 26 lines averaged producing 14% more forage than cleistogamous progeny. Since most of these lines were derived from similar material, one might expect even greater increases from outcrossed progeny of sericea of greater genetic diversity.

A similar study involving some of the same lines was located on an area that appeared to be infested with nematodes. The same relationships between lines and types of progeny were found. However, differences between types of progeny of certain lines were magnified. Chasmogamous progeny of one line produced 90% more forage than cleistogamous progeny. Another line in which both types of progeny produced high yields of forage, chasmogamous progeny produced only 6% more forage than cleistogamous progeny. Stands of cleistogamous progeny were generally thinner at the end of the second year than those of chasmogamous progeny. Differences here seem to have been the result of nematode

susceptibility among inbred lines as well as to genetic differences affecting heterosis. These data indicate the desirability of having outcrossed progeny of sericea.

How can heterosis in sericea be utilized? Lines have been selected at the Auburn University Agricultural Experiment Station that are genetically high and low in percentage of chasmogamous flowers and seed. Two of these were used to study the heritability of this characteristic. The low parent had 5% chasmogamous seed as a spaced plant and the high parent 98%. Both plants were uncut until seed harvest. Inbred lines from these were tested in replicated 40-inch rows in northern and central Alabama and the same relationship prevailed - the low percentage line remained low (approximately 10%) and the high percentage line remained high (approximately 70%). The F_1 reacted almost identically to the high parent, indicating dominance. F_2 data are presented in the table. No plant as low in percentage of chasmogamous seed as the low parent was recovered, indicating that more than one dominant gene is involved. The distribution indicates that this characteristic is highly heritable.

Summary

Heterosis occurs in sericea lespedeza. It might be utilized in this crop by managing it for seed production to favor maximum chasmogamous flowers and maximum crossing; by using genes that condition a high percentage of chasmogamous flowers and seed; crossing lines of great genetic diversity; and selecting lines for crossing which have a high yield base and also give increased yield when outcrossed.

References

Donnelly, E. D. The effects of outcrossing on forage and seed yields in sericea lespedeza, L. cuneata. Agron. Jour. 47:466-467. 1955.

Table 1. Frequency distribution of 180 F_2 of low- x high- chasmogamous seed lines, and of 15 chasmogamous progeny of the low parent by percentage chasmogamous seed. Tallassee, Alabama. 1963.

Percent chasmogamous seed	No. of plants F_2	No. of plants Low parent
0 - 9.9	0	4
10 - 19.9	0	10
20 - 29.9	2	1
30 - 39.9	2	0
40 - 49.9	5	0
50 - 59.9	5	0
60 - 69.9	11	0
70 - 79.9	28	0
80 - 89.9	51	0
90 - 100	76	0
TOTAL	180	15

245

<u>Utilizing Heterosis Through Apomixis</u> - E. C. Bashaw

Asexual reproduction permits immediate use of F_1 hybrids, preserves heterosis and eliminates sterility problems which often accompany wide crosses. The economic significance of vegetative propagation of hybrid grasses and fruit and vegetable crops is well recognized. Apomixis provides a unique method for the utilization of F_1 hybrids through seed without sacrificing hybrid vigor.

Geneticists and Plant Breeders have been able to demonstrate the potential value of apomixis for breeding purposes in a few species. Powers (3) reported apomictic guayule hybrids in 1945. In recent years grass breeders have produced some interesting and valuable apomictic hybrids. Burton and Forbes (1) produced superior apomictic hybrids by crossing sexual autotetraploid Pensacola Bahia females with apomictic common Bahiagrass males. Heterosis was maintained in progeny of the obligate apomictic F_1 plants and was rapidly lost in succeeding generations of sexual hybrids. Harlan et al (2) recently reported a number of hybrids between sexual and apomictic <u>Bothriochloa</u> and <u>Dichanthium</u> species.

Discovery of a sexual buffelgrass plant at College Station has led to development of a successful breeding program with this predominantly apomictic species. Cytogenetic investigation revealed that obligate apomixis is genetically controlled in buffelgrass and potentially useful for breeding purposes. Recent studies have shown that apomixis can be manipulated effectively in this species permitting mass production of true-breeding F_1 hybrids and new strains. It is now possible to combine the desirable characteristics of sexual and apomictic plants and maintain heterosis through apomixis. Promising apomictic strains have been produced by hybridization of sexual and apomictic plants and by selfing plants which are heterozygous for method of reproduction. Field evaluation of 25 new apomictic strains in 1964 showed that some were superior to the best commercial variety. One strain, which is outstanding in both forage and seed production, is being increased for possible release as a new variety. Over 1,000 F_1 hybrids between sexual and apomictic plants are being investigated for method of reproduction and potential agronomic value.

Genetic studies of method of reproduction in buffelgrass indicate relatively simple inheritance of obligate apomixis in this species. Evaluation of 528 selfed progeny of a sexual plant (heterozygous for method of reproduction) showed 445 sexuals and 83 apomicts, a ratio of 5.4:1. Ratios obtained from progeny grown in three different years have ranged from 15:1 to 13:3. Data obtained thus far show that hybrids between the sexual plant and two apomictic strains approach a 1:1 ratio. Study of 273 F_1 hybrids (sexual x apomict) showed 151 sexuals and 122 apomicts. These data indicate that obligate apomixis is controlled by no more than two genes. The nature of gene action is uncertain at this time. Efforts are underway to develop homozygous sexual plants for more conclusive genetic studies.

References

1. Burton, G. W. and Forbes, Ian. 1960. Intern. Grassl. Cong. Proc. 8:66-71.
2. Harlan, J. R., M. H. Brooks, D. S. BorgaonKar, and J. M. J. de Wet. 1964. Bot. Gaz. 125:41-46.
3. Powers, L. 1945. Genetics 30:323-346.

Heterosis and Quality in Tall Fescue - R. C. Buckner

Spaced plant nurseries of tall fescue were grazed with cattle and inbred progenies of the best grazed plants were selected for palatability for three generations.

The selfed and open-pollinated maternal sister lines were scored for vigor during each generation of selection. S_1, S_2, and S_3 lines were reduced in vigor approximately 35, 55, and 52 percent, respectively, when compared with their open-pollinated sister lines.

Polycross progenies and synthetics of S_2 and S_3 lines were approximately equal in yield to commercial varieties when evaluated in sod plots.

Correlation coefficients indicated little relation between vigor and palatability either in spaced plant nurseries or in sod plots.

F_1 hybrids of annual ryegrass x tall fescue and their amphiploid progenies exceeded both parents for length and width of flag leaf, length of inflorescence, and leaves per stem in a spaced plant nursery during the first year after establishment.

The relation between vigor and palatability was not evident in the annual ryegrass x tall fescue hybrids and their amphiploids.

II. Forage Physiology and Ecology Interest Group
R. H. Brown, Presiding

Maximum Production - H. Douglass Gross

When this title was proposed, it was suggested that the program should be a "practical" one. However, while considering what might be discussed under the guise of such a title, it seemed that a practical approach could easily lead to a simple recitation of what, to us, if not to all our students and farmer customers, have become more-or-less routinely recommended practices. Therefore, at the risk of seeming presumptuous, and fully aware that we might soon be in over our heads, we decided to undertake to review some plant

physiology and, with this as a base, propose what might be done, in our sphere of interest, to maximize forage crop yields.

Obviously, a forage crop is no better than the animal product it supports. However, for the sake of this presentation, we chose to assume that qualitative evaluation techniques would progress apace, that forage utilization schemes would follow the ever-increasing trend toward maximizing TDN preservation, and that we will continue to be a meat-eating people for some time to come. This is not to demean the problems concerned with quality, its definition and its evaluation at the earliest possible stages in any forage-production research program. Rather we acknowledge that, by contemporary standards, the resolution of qualitative problems, with particular emphasis on the quantitative and qualitative measurement of animal intake, is probably the number one problem facing "animal agronomists" in our time.

With this as a point of departure, let us assume that our goal is to maximize energy, TDN, and/or dry matter production per unit area and hopefully, per unit of input (dollars). This latter is such a relative question that we have chosen to consider production per unit area as the more critical.

What are the factors that limit production at the present? The following chart suits our purposes, though it may not fit all situations:

- Managerial Skill
- Disaster
- Method of Utilization
- Genetic potential
- Edaphic aspects
  - Fertilizer management
  - Water management
- Climatic aspects
  - Temperature
  - Precipitation
  - Light
  - CO_2

It could be argued that these are not ranked properly or that they should be presented in a cyclic, or interdependent, fashion. Both may be correct, but let us consider the factors as they occur, without belaboring the validity of the schematic.

We are not prepared to discuss managerial skills. However, whether or not you, as a research worker or educator, consider it to be in your province, it is the main limiting factor at present. Despite the many dedicated man-hours which have gone into the dissemination of our knowledge, we, in North Carolina, are put in the position of having to admit that the majority of our farmers not only do not use the quantities of fertilizer we would like to see, but also they are off-course in the quality (ratio) they normally apply.

The next category merely serves to lump diseases, insects, wind, hail, rodents and all of the possible calamities which might befall anyone who gambles on the benign attitude of nature.

The method of utilization can obviously vitiate all of the work involved in the factors below it. To take an extreme case, the crop of pearl millet left in field until it is thoroughly dry, the seed have all shattered, and the leaves torn has little value regardless of the dollars spent in getting it to that stage.

Certainly, the genetic potential of the species under consideration is going to make itself felt throughout any production program. Therefore, we will mention it at this point, and refer to it again before we close.

As regards the edaphic factors, we have little to say. Several specialists who concern themselves with fertilization and soil management have told us that they think we have reached a practical fertilizer management ceiling. That is to say, they feel that they have at hand the information necessary to reach the limits imposed by the other factors in the diagram, with particular and pointed reference to the genetic potential of the species in current use.

The irrigation aspect poses more interesting problems. It seems that the consensus is that irrigation is fine when you need it as long as you don't have to buy the equipment with forage-based income. It is our thesis that this is an oversimplification. Just during the past two years, the members of a sub-committee of S-47 with which I have been associated have had something approaching 70% stand failure due to drought in establishing a regional test. We can talk about weather cycles and hydrogen bombs all we want, but just in this one simple instance, considering land preparation through stand establishment costs, we could have justified a fair amount of irrigation gear. As we accumulate more information relative to expected frequency of soil-moisture stress, the importance of supplemental water increases at a rapid rate (19). Several of our colleagues have said, for example, that they would not go into a livestock production enterprise in the Piedmont without irrigation facilities.

To move on, we should consider the climatic factors as they impose upper limits on energy production per acre.

Temperature has, and continues to, limit production in many areas of the world. This factor has been thoroughly reviewed by many writers. Suffice to say that we usually consider this factor in three respects, maximum, minimum and optimum. Obviously, this particular component of the environment has far-reaching effects which are most readily apparent in the distribution of economic species, particularly in those regions where total precipitation is not limiting.

Precipitation, quantitatively and qualitatively, is closely allied with the aspect of irrigation mentioned above. At least in the humid East, precipitation is usually considered to be sufficient for good crop production. This it may be, but it is not always provided in the amounts needed, at the right time. On soils of low moisture-holding capacity, you need not be told that this often, and often seriously, limits our production potential. Certainly, little water is actually used in dry matter production, but a lot is needed just to keep things wet enough to function properly.

Then come the factors of CO_2 and light, and these are the things I would like to discuss at some length.

Scientists have been concerned with the problems of photosynthesis and respiration for almost two centuries. In seven years we will observe the 200th anniversary of Priestley's pronouncements. We are all aware that the last ten years have seen tremendous advances made in this area, with particular regard to the photosynthetic process. It has become fashionable to calculate how efficient plants are in converting light energy into something more readily digested. Several of these estimates are summarized in Table 1.

Table 1. Some Theoretical Maxima of Dry Matter Production.

Estimated Maximum Kg D.M./Ha/day	Converted* from the data of:	Conditions
217	Bonner (6)	
315	de Wit (7)	June in Netherlands
400	Saeki (20)	
772	Loomis & Williams (14)	Quantum yield
1141	Talling (16)	Single-leaf layer
1422	Hesketh & Moss (11)	Enriched atmosphere
1766	Talling (16)	Crop Stand
2470	Sprague & McCloud (21)	Caloric inputs

*$CO_2:CH_2O:C$ = 44:30:12. These maxima cannot be compared directly because of different bases of estimate.

It is interesting to note some reported maximum yields as cited in Table 2. Many of these approach or surpass the calculated maxima of Table 1.

Table 2. Some Reported Dry Matter Yields of Rates of Production.

Yield Kg D.M./Ha/day	Converted* from the data of:	Conditions
150	de Wit (7)	Grass, Netherlands
200	Alberda (1)	Sugarbeet
260	Vincente-Chandler (25)	Elephantgrass, year-long
326	Many pre-1920 authors	
540	Begg (4)	Millet, 15-day period
655	Muramoto (18)	Sunflower
703	Lemon (13)	Field corn
982	Muramoto (18)	Sorghum
982	Hesketh (8), Muramoto (18)	Field corn
1440	Baker (3)	Field corn, 15-min. period

*These yields should not be compared directly due to differences in the conditions under which they were measured.

However, the discouraging aspect is that even the best of these represents an efficiency of conversion of absorbed-quantum energy of about 20% and the average efficiency for solar energy for all crops is probably lower than 2%. It has been calculated that this is about 1/2 the maximum attainable efficiency.

What limits photosynthetic efficiency?

Certainly many factors could be suggested. But let us assume that neither water nor minerals are in any way limiting. (That this is rarely the case in practical agriculture is readily admitted.) Under these conditions, the following factors become limiting (6):

1. At low light intensities, where CO_2 is not limiting, the quantum efficiency of photosynthesis is low.

2. At higher light intensities, photosynthesis is limited by the quantum efficiency of the process plus the wastage of light energy inherent in the low light-saturation level of the chloroplasts, and

3. At high light intensities, CO_2 at the cellular level becomes the limiting factor.

Of these situations, the one most commonly occurring in agricultural regions during the growing season, is the relatively low cut-off point imposed by the chloroplasts. Secondly, the amount of CO_2 available comes into play.

What can we do about it, and what am I driving at?

Let us look at the energy input situation a little more.

Obviously, a crop in the field is not a single leaf, nor is it usually a single layer of leaves. Therefore, in considering photosynthesis in the field, it is necessary to consider such factors as total leaf area (LAI), mutual shading, absorption, transmission, and reflection of light within the vertical maze formed by crop leaves.

The difference between single-leaf layers and crop-leaf efficiency was pointed out in the earlier table from the estimates of Talling (16). The crop was estimated to be about 50% more productive of dry matter. This is due to the fact that leaves, though they shade the lower layers, both transmit and reflect some portion of the incident light. Therefore, though a lower leaf may be masked by an upper, it need not be in light so dim that it is ineffective photosynthetically. This effect has been demonstrated by McCloud in his study of the contribution to the overall assimilation of the various leaf layers of millet and bermudagrass stands (2, 15).

The Japanese have investigated this effect as it may be influenced by leaf morphology, leaf anatomy and leaf angle. They have found considerable variation in both factors, reflectance and transmission, within species and among varieties of rice (23).

Verhagen (24) has used a mathematical approach to the problem of light extinction in a crop stand. He indicates that it is possible with a standard exponential foliage (for which each increment increase in leaf area changes the extinction coefficient so that the bottom leaves are always at the compensation point) to have a high leaf area index and still have a lot of light hit the ground. This theoretical approach has been partially confirmed by the field work of the Cornell group. Hesketh and Moss (11), for example, indicated that for high-yielding corn, the amount of light incident to the soil surface was sufficient to sustain yet another increment of photosynthesis.

It seems that much of this work indicates that LAI alone is not the answer to the maximum efficiency problem. One should consider also the type of leaf involved and its mode of display. One could speculate, therefore, that a part of the success of Coastal bermuda in achieving such high yields, as compared to common, might be due to the well-known differences in deflection angle of the leaves.

Yet another aspect of foliage effects on photosynthetic efficiency is the matter of CO_2 diffusion. Obviously the CO_2 content of the air immediately above the crop can, at times, be a potent limiting factor. This has lead some authors to speculate on possible means of increasing turbulence over a crop canopy, or otherwise enriching the CO_2-supply at the leaf-air interface. But the literature indicates that the more normal situation is that of resistance to rapid diffusion within the leaf itself.

Many field trials have indicated that a considerable closure of stomata may take place without affecting photosynthetic rate. El-Sharkawy (8) demonstrated that it was possible to completely seal the top stomates in sorghum without affecting assimilation rates.

Hesketh's work (10) indicated that rate differences between species are caused by "simple physical differences in resistance to diffusion or in the concentration of CO_2 at the site of its acceptance within the leaf." Gaastra (9) approached the problem on a theoretical basis. He developed a formula to demonstrate that it is possible to reduce mesophyllic resistance to gas diffusion without increasing water-loss through transpiration.

Deeper within the leaf lies yet another factor which vastly limits the efficiency of crop photosynthesis. This is the result of the basic intracellular make-up of the photosynthesizing cell. If, in simplified form, we can consider the chloroplasts as light-gathering, or energy-storing, panels, we might say that we have a poorly-engineered electrical circuit. There are approximately 2000 chlorophyll molecules present for every CO_2-reduction site. Each chlorophyll molecule can utilize one quantum at a time. This occurs about one time/second at 1/10 full sunlight. About 10 chlorophyll molecules must be excited before a CO_2 molecule can be reduced. However, the actual reduction can take place in much less time than 1 second. Thus, at low light intensities, with numerous light collectors wired into one receptor, the system is fairly efficient. But as light intensity increases, the number of collectors excited per unit time increases. More than 10 quanta may become available at one time. But all the available energy is directed to one receptor. So the power potential which may have accumulated is dissipated into other channels, and the system settles back to zero to be activated all over again. Obviously, at high light intensities, a ratio of 100:1 would be much more efficient than the present 2000:1.

All of this has been set forth by Bonner (5, 6). He suggested that a more efficient system might be to have "modulating chloroplasts." These would have several receptors per aggregate of chlorophyll molecules. At low light intensities, only one or a few of these would be shunted into the circuit. As light intensity increased, as energy input per unit time increased, more and more receptors would be shunted in. Thus, the efficiency of each chloroplast would tend to remain constant, or at least would not become saturated at what are now relatively low energy-inputs.

Where does this lead us in terms of maximum production?

To cover our earlier assumptions, we must guarantee that mineral supply is never limiting. This is well-known but not widely achieved. We should avoid moisture stress at any time. This area needs more research, particularly as regards the economics of irrigation.

We should strive to maintain a relatively closed leaf-canopy, at least in terms of light striking the soil surface. In this regard, it is interesting to note that Shaw at Iowa State has recently demonstrated that even in that area of high yields, soybean stands are normally too open to permit maximum bean yields.

Finally, we submit that we should be doing more to apply the knowledge of production-physiology which we now have available to the management of existing species. Moreover, and perhaps even more important, we should be encouraging those whose job it is to produce new material to utilize the physiology presently available, and we should be making sure that more is made available. Two recent reviews, one concerning legume-, and the other grass-, breeding, in the long-range sense, went into considerable detail regarding plant type, quality and method of utilization. Neither of them contained the faintest glimmering of an awareness of the possibilities of changing what we have come to regard as standard.

We have all heard, many times, the plaint "if we had the man-hours that the corn or small grain people have, we would have better forage types or varieties." To my knowledge, few plant-breeding groups are now involved in breeding for a physiologically-efficient type.

That this is not completely out in left field, and that plants can be modified to suit crop physiology, and not evolutionary physiological needs, is indicated by the results these groups have obtained to date. The basic ideas have been in the literature for some time and have recently been reiterated by Mitchell in New Zealand (17) and Jennings in this country (12). Several "pure" physiologists have made the same plea in recent literature as regards changing the color of plants (26), the mesophyllic structure (3, 10), and the chloroplast arrangement (6, 14).

The material is probably available. For example, heat tolerance in Arabadopsis is controlled by a single gene. Bienniality in Hyosyamus is a single-gene characteristic. Talling (22) suggests that continental species show more variation in photosynthetic rates than do tropical or maritime types. Further, he cites examples of intra-specific variation in photosynthetic response. Even more intriguing are the possibilities suggested by McCloud (16), citing Nishida, that members of the Crassulaceae fix CO_2 at night.

I should like to remind you that Hesketh has reported that among the species he studied, corn, not an insignificant forage plant, had the lowest chlorophyll content, the thinnest leaves, the lowest absorptivity and the "least light-intercepting ability." If you will recall the figures in the second table, corn holds a respectable position in terms of rates of production. For me, this sums up the challenge facing us today.

In conclusion, I submit that if forage crops are to remain competitive for the stockmen's time and money, we must start now to supply the sorts of crop physiological knowledge necessary to tailor plants for the job which they are required to do.

Citations

1. Alberda, T. Neth. J. Agric. Sci. 10:325-333. 1962.
2. Alexander, C. W. and D. E. McCloud. Crop Sci. 2:132-135. 1962.
3. Baker, D. N. and R. B. Musgrave. Crop Sci. 4:127-131. 1964.
4. Begg, J. E. Nature. 205(4975):1025-1026. March 6, 1965.
5. Bonner, James. Chapt. 22 in Growth in Living Systems. Basic Books, Inc. 1961.
6. Bonner, James. Science 137(3523):11-15. 1962.
7. de Wit, C. T. Neth. J. Agric. Sci. 7:141-149. 1959.
8. El-Sharkawy, M. A. and J. D. Hesketh. Crop Sci. 4:619-621. 1964.
9. Gaastra, P. Neth. J. Agric. Sci. 8:83-84. 1960.
10. Hesketh, J. D. Crop Sci. 3:493-496. 1963.
11. Hesketh, John D. and Dale N. Moss. Crop Sci. 3:107-110. 1963.
12. Jennings, Peter R. Crop Sci. 4:13-15. 1964.
13. Lemon, Edgar R. Agron. J. 52:697-703. 1960.
14. Loomis, R. S. and W. A. Williams. Crop Sci. 3:67-72. 1963.
15. McCloud, D. E. Crop Sci. In Press. 1964.
16. McCloud, D. E. et al. Adv. in Agron. 16:1-58. 1961.
17. Mitchell, K. J. Proc. N. Zeal. Inst. Agric. Sci. 9:80-86. 1963.
18. Muramoto, H. et al. Crop Sci. 5:163-166. 1965.
19. Robinson, R. R. Agron. J. 55:307-308. 1963.
20. Saeki, Toshiro. The Botan. Magazine (Tokyo). 73:55-63. 1960.
21. Sprague, V. G. and D. E. McCloud. Chapt. 36 in Forages. Ioa. State Univ. Press. 2nd Ed. 1962.
22. Talling, J. F. Ann. Rev. Pl. Physiol. 12:133-154. 1961.
23. Tanaka, A. et al. Techn. Bul. 3. International Rice Research Institute. 1964.
24. Verhagen, A.M.W. et al. Ann. Bot. N.S. 27:627-640. 1963.
25. Vicente-Chandler, Jose et al. J. Agr. Univ. P.R. XLIII:215-227. 1959.
26. Went, Fritz W. Growth in Living Systems. Basic Books, Inc. 1961.

Trends in Forage Crop Systems in the Southeast - C. Y. Ward

During recent years in the Southeastern United States we have seen a sharp increase in grassland farming and cash receipts from livestock. This trend should continue with more emphasis on:

1. The use of more silage and other stored forage.

2. The use of more high yielding annuals.

3. Increased dry-lot grain feeding of beef cattle.

4. The use of pelleted or wafered forages.

There are many reasons why the South will and must continue to make great strides as a meat and milk producing area. Among the more important reasons are these:

1. The need for more meat and milk to meet the needs of a rising population. The population of the 13 Southern states is predicted to increase by approximately 20 million by 1975. The largest gains will be through the Piedmont area, the Gulf Coast and the Dallas-Houston area of Texas.

2. There is a need for more beef of grades above commercial. Many Southern states now purchase over 80% of their Good and Choice grades from the Midwest.

3. The acreage devoted to cash crops such as cotton, tobacco and soybeans is predicted to further decline. This acreage most logically will go to pastures. These acres could become our best pasture or forage crop land since they are a better class of land than much presently in pastures.

4. Milder temperatures afford the South a longer growing season and the rainfall for the region is higher than any other in the United States. This fact affords more flexibility in cropping systems.

5. We have a vast reservoir of unimproved pastures. Only 10% of the 140 million acres devoted to grass and legumes is really improved. The improved yields available through the use of fertilizer on much of this reservoir would allow for increased cattle numbers and better quality beef.

6. More new forage crops are available to the farmer than ever before. In the past 25 years, experiment stations in the Southern region have released 73 new varieties of forage crops.

7. More research is being conducted with forage crops in the Southern region than ever before. The number of forage crop researchers has increased steadily from 45 in 1940, to approximately 160 at the present time.

Production and Management of Summer Annual Grasses - H. A. Fribourg

Summer annual grasses have become increasingly important and used in the past few years, particularly in enterprises where a reliable source of large amounts of quality forage is required. The first impetus was provided by improved varieties of pearl-millet, such as Starr and Gahi-1, which provide more forage than

Sudangrass, grow later in the season and are less susceptible to disease. In the last few years, the production of hybrids of Sudangrass and Sorghum has been made possible by the use of the male-sterile method. This has resulted in a large number of varieties of differing characteristics for which seed is available commercially. All these plants can be grazed, green-chopped or even, if desired, may be used as stored feed. High yields have been obtained when these plants were well fertilized, grown on soils of high potential productivity, and properly managed. These annual grasses respond well to fertilizer applications, particularly nitrogen. However, management is very critical, i.e., stage of growth at which they are harvested, frequency of harvest, stubble height, etc.

There are wide differences existing among species and varieties in the distribution of their production of dry matter throughout the summer. Piper Sudangrass in Tennessee characteristically makes good growth early in the season, but climatic conditions and disease result in low production after the middle of August. The pearlmillets start growth more slowly in the early summer, but continue vigorously through late summer. When 30" growth was cut to a 6" stubble in Tennessee, Gahi-1 produced more forage, and grew later in the season, than did Starr. Some of the hybrids, such as Sudax SX-11, are more vigorous than Piper Sudangrass, and maintain their growth as well as Starr in August and September.

The effect of different management schemes on pearlmillet has been studied for a number of years in Tennessee. A 3" stubble removed practically all the apical meristematic buds, so that most of the stems were dead and any new growth came from tillers. A 6" stubble was less severe, but still only 20% of the stems were left with an apical bud by August 1. With a 10" stubble, such a condition was delayed for several weeks. Not only was this effect translated in terms of total production throughout the season, but it affected the distribution of this production over time. When 20" growth was cut to a 3" stubble, most of the production occurred in late June, July and early August. By changing the stubble height from 3" to 10", production was maintained throughout July, August and the first half of September. In addition, as the height of stubble was increased, not only was total yield of dry matter increased, but so was the leafiness of the material produced and harvested.

In a grazing situation, one would expect greater damage to the plants than when green-chopping, for the animals will remove more of the succulent plant parts containing the buds, regardless of the height of these terminal buds above the ground. Nevertheless, knowledge of the principles involved should facilitate the making of grazing management decisions that will result in better regrowth of the plants.

In view of the findings at Tennessee and at other experiment stations, it is recommended that pearlmillet should not be cut below a 10-inch stubble if green-chopped, and Sudangrass not below 6 inches.

This kind of management is more difficult to accomplish in grazing, but can be approximated with rotational grazing. The sorghum hybrid varieties should be left with approximately an 8-inch stubble; research is under way at the present time to determine more accurately the effect of stubble height on the hybrids.

State Forage Testing Programs - J. P. Fontenot

There are large variations in quality of forages, and it appears that farmers are not capable of accurately assessing forage quality by visual evaluation. Therefore, laboratory testing of forages for quality is a logical approach. The main objectives of forage testing are 1) to improve forage quality and 2) to enable farmers to efficiently utilize forages, regardless of quality.

In June 1965, thirty-three (33) states had forage testing programs. Samples are analyzed in commercial laboratories in some states, in university laboratories in some and in feed control laboratories in some. Cost per sample varies between none and $8.50 per sample. Various methods are used by the states in assessing nutritive value of forages. Probably none of the programs are perfect. However, use of any of the forage tests is superior to visual evaluation by the farmer.

Tuesday - June 22 - Evening

AWARDS BANQUET

The Birds, the Bees and the Flowers or "Looking and Seeing" - A. S. Heilman, Department of Botany, University of Tennessee.

A slide presentation of flowers and plants, mostly of the Smokey Mountains area.

Presentation of Awards - D. E. McCloud

Dr. McCloud and representatives of 13 states selected, among charter members of SPFCIC, the following persons as contributing most to forage work for the past 25 years, 1940-1965: Roy E. Blaser; Robert H. Lush; Otto E. Sell; Ernest N. Fergus; Roy L. Lovvorn; Hugh W. Bennett; William W. Woodhouse, Jr.; Dana G. Sturkie; Olaf S. Aamodt; Raymond B. Becker; Glenn W. Burton; Mason A. Hein; Eugene A. Hollowell; Thomas H. Rogers; Benjamin W. Smith; James L. Stephens; B. W. Southwell; Paul Tabor; and J. K. Underwood. A plague was awarded to each recipient with the following inscription:

"Presented to _____________, Charter Member Southern Pasture and Forage Crop Improvement Conference - In Recognition of Twenty-five Years of Distinguished Service and Achievements in Forage Crops, 1940-1965."

Historical Note - C. Y. Ward

In 1939 the pasture and forage specialists in the South were aware of the need to establish an organization to promote and coordinate the research work already underway concerned with the production and improvement of feed and livestock in the southern states. At the 1940 meeting of the Southern Agricultural Workers in Birmingham, Alabama, the President of the association, Dean Schoeb of North Carolina, appointed a committee to explore the possibilities of arranging a Southern Pasture and Forage Crop Conference, under the chairmanship of Dr. R. L. Lovvorn of North Carolina, with Glenn Burton of Georgia, D. G. Sturkie of Alabama, G. W. Ritchey of Florida, and H. W. Bennett of Mississippi as members. The report of this temporary committee was approved and the following day a permanent organization was established. Dr. Ben Smith of North Carolina acted as secretary. An executive committee was elected with Roy Lovvorn as chairman, Glenn Burton, E. N. Fergus, and Roy Blazer as members, and O. S. Aamodt as permanent secretary.

Following the organizational meeting the permanent secretary called on all of the southern State Experiment Stations to discuss objectives, organization, procedures, and meetings with each institution specialists, department heads, and experiment station directors. It was agreed that in addition to the working conference of technical specialists and extension workers that programs should be organized on a regional basis to inform the farming public and other agricultural organizations of the work and accomplishments of the conference group.

Following the first technical conference at Tifton, Georgia, in 1940, a general conference was arranged with the support of Director S. H. Starr of the Coastal Plain Experiment Station and President George King of the Abraham Baldwin Agricultural College. Approximately 500 people attended.

The success of the first conference was due in no small part to these leaders and the staff support of Glenn Burton, B. L. Southwell, P. L. Stephens of Tifton, and W. W. Woodhouse and E. D. Abfander of North Carolina. The following year Dr. Ralph Cummings, Director of N. C. State Experiment Station was appointed by the Southern Land Grant College and Experiment Station Directors as the advisor to the Southern Pasture and Forage Crop Improvement Conference.

Announcements:

Dr. Fribourg announced 75 in attendance at the Banquet, 106 registered for SPFCIC. Arrangements for travel to the Grasslands Field Day were explained.

Report of Resolutions Committee - T. H. Taylor, E. R. Beaty, and W. E. Knight, Chairman. Report given by W. E. Knight.

"Be it resolved, the Southern Pasture and Forage Crop Improvement Conference members deeply appreciate the hospitalities extended and facilities furnished them during the twenty-second meeting at Nashville, Tennessee. Thanks are especially offered Henry A. Fribourg, local Chairman; University of Tennessee staff members; and to all conference officers for their part in making the conference a success.

And be it further resolved, the Southern Pasture and Forage Crop Improvement Conference members give special thanks to the program participants for their preparation and presentation of papers. Thanks are especially offered to Dr. D. E. McCloud who has served so effectively as Permanent Secretary and for his efforts in publishing the minutes of the meetings. And be it further resolved that the members of this conference pledge full support and cooperation to the newly elected Permanent Secretary Dr. Leffel. We move that this resolutions be recorded in the minutes of the meeting and letters of thanks and appreciation be sent to Dean Pendergrass, Director Ewing and local Chairman Fribourg."

Chairman Ward introduced incoming chairman W. B. Anthony. The Executive Committee meeting was announced as scheduled immediately after the Banquet, in Parlor A.

EXECUTIVE COMMITTEE MEETING MINUTES

C. Y. Ward, Presiding

The meeting of the Southern Pasture and Forage Crop Improvement Conference Executive Committee was called to order by Chairman Coleman Ward at 9:38 p.m.

The motion - "that outgoing and incoming representatives from each interest group are invited to participate in final Executive Committee meeting of each year - and that each interest group will be entitled to one vote at said meeting" - carried.

Plans for location of the 1966 meeting were discussed. Tentative sites are Blacksburg, Virginia, 1966; Louisiana, 1967; and Raleigh, North Carolina, 1968. An official letter of invitation will be necessary. The Secretary was requested to summarize past meeting sites, as follows:

State			
Maryland			1961
Virginia		1953	
North Carolina	1941, 1949		
South Carolina		1958	
Georgia	1940	1956	
Florida	1947		1964
Alabama		1951	1963
Mississippi	1948	1959	
Louisiana		1952	
Texas		1950	1962
Oklahoma		1954	
Arkansas			1960
Tennessee		1955	1965
Kentucky	1942	1957	

The motion - "that the Executive Committee delegate authority to the Chairman to accept an invitation for the 1966 meeting" - carried.

The motion - "that the Secretary write a letter to Chairmen of each interest group, inviting interest groups to continue participation in the Southern Pasture and Forage Crop Improvement Conference, and inviting Chairmen to participate as members of the Executive Committee" - carried.

The composition of interest groups and Executive Committee was reviewed:

Group	Admin. Adv.	Past Chairman	Current Chairman
(S-45)	G. H. King	C. B. Browning	W. V. Chalupa
(S-46)	O. B. Garrison	E. F. McClain*	E. S. Horner*
(S-47)	R. L. Lovvorn	W. W. Huffine	H. D. Gross*

- -

SPFCIC Executive Committee	Past-Past Chairman	O. C. Ruelke*
	Past Chairman	C. Y. Ward*
	Chairman	W. B. Anthony*
	Chairman Elect	H. A. Fribourg*
	Chairman Elect-Elect	L. H. Taylor*
	Permanent Secretary	R. C. Leffel*

*Present during current meeting

The motion - "that the Secretary provide copies of Executive Committee meeting minutes as soon as possible" - carried.

The Secretary was requested to contact previous Secretaries for possible By-Laws for Southern Pasture and Forage Crop Improvement Conference.

Dr. Fribourg suggested a series of deadlines to facilitate future programming. Dr. Ruelke suggested a listing of workers by disciplines to facilitate programming - and that the listing be available to Interest Group Chairmen.

A suggested program for 1966 Southern Pasture and Forage Crop Improvement Conference was:

1st. a.m.	Host Institution Program
1st. p.m.	Tours
2nd. a.m.	Interest Groups
2nd. p.m.	Joint Session

The motion - "that above format be adopted for next year's meeting" - carried.

It was suggested that Chairmen of Interest Groups appoint program arrangers for each interest group session with Southern Pasture and Forage Crop Improvement Conference.

The meeting was adjourned at 10:55 p.m.

REGISTRATION LIST - 1965

Name	State	Address
Anthony, W. B.	Alabama	Auburn University
Cope, J. T.	"	" "
Donnelly, E. D.	"	" "
Evans, E. M.	"	" "
Johnson, W. C.	"	" "
Jordan, C. W.	"	U.S. Borax & Chemical Corp.
King, C., Jr.	"	Auburn University
Mays, D. A.	"	Tennessee Valley Authority
Russel, D. A.	"	" " "
Sturkie, D. G.	"	Auburn University
Wellhausen, H. W.	Arkansas	Agric. Extension Service
Duck, B.	Florida	Fla. Agric. Expt. Sta.
Dunavin, L. S.	"	West Fla. Agric. Expt. Sta.
Harris, H. C.	"	University of Florida
Horner, E. S.	"	" " "
Killinger, G. B.	"	" " "
Kretschmer, A. E., Jr.	"	Indian River Field Lab, Ft. Pierce
West, S. H.	"	University of Florida
Adams, W. E.	Georgia	Watkinsville
Burns, R. E.	"	Ga. Agric. Expt. Sta.
Cummins, D. G.	"	" " " "
Forbes, I.	"	Ga. Coastal Plain Expt. Sta.
Goins, W. P.	"	Armour Agric. Chem. Co.
Gore, U. R.	"	Ga. Agric. Expt. Sta.
Harris, H. B.	"	" " " "
Hart, R. H.	"	Ga. Coastal Plain Expt. Sta.
Minton, N. A.	"	" " " " "
Morcock, J. C., Jr.	"	Allied Chemical Corp.
Newton, J. P.	"	Ga. Agric. Expt. Sta.
Powell, J. B.	"	Ga. Coastal Plain Expt. Sta.
Sell, O. E.	"	Ga. Agric. Expt. Sta.
Wells, H. D.	"	Ga. Coastal Plain Expt. Sta.
Wilkinson, S. R.	"	Southern Piedmont Conservation Research Center
Wofford, I. M.	"	Southern Nit. Co., Savannah
Garrard, H. L.	Indiana	American Potash Institute
Heath, M. E.	"	Purdue University
Hood, E. L.	"	" "
Kaiser, C. J.	"	Dubois

Name	State	Address
Buckner, R. C.	Kentucky	University of Kentucky
Fergus, E. N.	"	" " "
Taylor, N. L.	"	" " "
Taylor, T. H.	"	" " "
Mondant, C. L., Jr.	Louisiana	Louisiana State University
Monroe, W. E.	"	" " "
Nelson, B.	"	Southeast La. Expt. Sta.
Owen, C. R.	"	La. Agric. Expt. Sta.
Aamodt, O. S.	Maryland	Hyattsville
Carlson, G. E.	"	USDA, Beltsville
Hanson, A. A.	"	" "
Henson, P. R.	"	" "
Leffel, R. C.	"	" "
McCloud, D. E.	"	" "
Bennett, H. W.	Mississippi	Mississippi State University
Knight, W. E.	"	" " "
Thurman, W.	"	" " "
Ward, C. Y.	"	" " "
Wards, N. E.	"	" " "
Cox, T. R.	New Jersey	American Cyanamid
Blake, C.	North Carolina	N. C. State University
Chamblee, D. S.	" "	" " " "
Cope, W. A.	" "	" " " "
Gross, H. D.	" "	" " " "
Lovvorn, R. L.	" "	" " " "
Timothy, D. H.	" "	" " " "
Woodhouse, W. W., Sr.	" "	" " " "
Huffine, W. W.	Oklahoma	Oklahoma State University
Fortuno, J. V.	Porto Rico	University of Porto Rico
Rios, A. S.	" "	" " " "
Beinhart, G. E.	South Carolina	Clemson University
Gibson, P. B.	" "	" "
Jutras, M. W.	" "	" "
McClain, E. F.	" "	" "
Berggren, F.	Tennessee	University of Tennessee
Ewing, J.	"	" " "
Fribourg, H. A.	"	" " "
Gray, E.	"	" " "
Hamilton, J. D.	"	Austin Peay State College
Heilman, A. S.	"	University of Tennessee
Huddleston, W. J.	"	Box 66-A Tennessee Tech

Name	State	Address
Jent, C. H.	Tennessee	561 U.S. Courthouse, Nashville
Lusk, R. H.	"	University of Tennessee
Montgomery, M. J.	"	" " "
Peacock, N. D.	"	" " "
Pendergrass, W.	"	" " "
Reynolds, J. H.	"	" " "
Springer, D. K.	"	501 U.S. Courthouse, Nashville
Wagner, R. E.	"	American Potash Institute
Whatley, T. J.	"	University of Tennessee
Williams, J. N., II	"	" " "
Bashaw, E. C.	Texas	Texas A & M University
Craigmiles, J. P.	"	Rice-Pasture Expt. Sta.
Holt, E. C.	"	Texas A & M University
Blaser, R. E.	Virginia	Va. Polytechnic Institute
Brown, R. H.	"	" " "
Bryant, H. T.	"	Box 13, RD 2, Middleburg
Fontenot, J. P.	"	Va. Polytechnic Institute
Lewis, W. W.	"	" " "
Miller, J. D.	"	" " "
Shoulders, J. F.	"	" " "
Taylor, L. H.	"	" " "
Smith, D.	Wisconsin	University of Wisconsin
Richards, C. R.	Washington, D.C.	USDA, Cooperative State Research Service